Ventilation Blocks: Design Feature In Malaysia Public Schools

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Hot and humid climate conditions have always been a challenge to building designers in tropical countries. Mouldy façade can emerge within a few days due to heavy rain and a room can easily become hot and musty. These are among the major issues caused by improper ventilation. To overcome these problems, ventilation block, an ingenious building element that has a long history, is widely used in tropical countries. It provides comfort through cross ventilation, permitting daylight and offering protection from heavy rainfall and, giving aesthetic value. This paper is part of the main research on the findings of passive design elements in Malaysia schools buildings. The main purpose of this paper is to investigate, identify and discuss on the types, the design features and the characteristics of the ventilation blocks found on the existing primary school buildings in Kuala Lumpur territory, Malaysia. A total of 85 from a list of 201 schools were visited and observation was made. The schools were selected and categorised according to the years they were founded and based on the findings of their architectural design influences. It was found that there were at least 10 different ventilation block designs among the schools sampled in the present study which were built between the 1950s and 1960s. This element can be found in various locations of the buildings. Nevertheless, the purpose of such element was clearly to provide good ventilation and comfort to the occupants. Combining architecture and cross ventilation as a design feature has led to the implication of using ventilation block may not only solve the problems identified but also add value to the building and a present a convincing strategy towards sustainable design approach.

Keywords: *Ventilation block, School building, Architectural feature, Passive design strategy*

1. INTRODUCTION

Ventilation is the method that is often used in applying the passive cooling strategy in addressing energy efficiency building issues. Ventilation can be divided into two types, namely, natural and mechanical. Ventilation is an important aspect in indoor environment and one of the basic elements that have always been considered in building design. Ventilation is a common strategy used to achieve user comfort level in countries which have hot and humid climate such as Malaysia. There are studies conducted on ventilation and the importance of ventilation on occupants' health, its impact on the environment and energy consumption in buildings locally and abroad (Muhamad Salleh, Kamaruzzaman, Sulaiman, & Mahbob, 2011), (Becker, Goldberger, & Paciuk, 2007). Furthermore, ventilation is not something recent but has been studied since the early 20th century. A comprehensive study was conducted by the New York State Commission (Duffield, 1929) on the principles and practice, and the impact of ventilation on health which has improved the enactments promulgated under the laws of the country. Sustainability has been implemented in building design of schools, which has made important contribution to the literature on sustainable design, akin to that of commercial buildings. Sustainable design approach has to be considered not only in programmes and learning materials but also in the physical environment aspects. School is a child's second home and by observing the facilities and the conditions in schools, attention to the physical space of the learning environment should be taken seriously since children spend at least 25% of their time at school. Children who are exposed to polluted air would be prone to suffer asthma, and other airborne diseases as their physical ability to deal with toxic chemical is less compared to that of an adult (Bakó-Biró, Clements-Croome, Kochhar, Awbi, & Williams, 2012). Therefore, requirements in providing complete infrastructure with additional focus on the

physical environment should be addressed in the design of educational facilities.

1.1 NATURAL VENTILATION

Many scholars have discussed the importance of building ventilation and its effects on humans. The intended effect here refers the impact on the human comfort level or indoor thermal comfort. In addition, the relationship between ventilation and the efficiency of energy use has also been studied (Perez & Capeluto, 2009; Wang et al., 2014). In order to produce a building that has minimal energy consumption or optimum passive energy efficiency, natural ventilation is one of the cooling strategies that can be applied. Apart from examining the relationship between building ventilation and its effect on humans, there are also studies that discuss the effect of natural ventilation on urban design. This study has found that better daylight and natural ventilation can be achieved through the design of high-density city by varying the skylines (Ng & Wong, 2004). This proves that natural ventilation must not only be considered at micro level, that is, in the design of a room or building but also in the design strategy at the macro level which refers to the design of a city in order to achieve optimal results even though the approach is different.

In general, a building design that uses natural ventilation as cooling strategies varies depending on the climate. Regardless of the season, natural ventilation remains a priority in the strategy to generate cooling in a room or building. Firth and Cook (Firth & Cook, 2010) have stated in their research on building simulation method that efficient use of natural ventilation can reduce overheating problems that frequently occur mainly in the summer for schools in the United Kingdom. This overheating problem has affected the comfort level and affected the performance of the occupants. There has been a clear evidence closely related to performance showing that low ventilation rates in classrooms have a negative effect on memory and concentration of pupils which may further lead to deterioration of health (Bakó-Biró et al., 2012; Mishra & Ramgopal, 2015; Salleh, Kamaruzzaman, Sulaiman, & Mahbob, 2011). This statement has also been echoed by several other studies related to the correlation between natural ventilation and health, environment and learning performance. In addition to studies in the western countries, local Malaysian studies have also discussed the subject matter extensively and seriously in examining the effects of natural ventilation on building performance as well as occupant performance. Among these studies was the investigation of the energy efficiency level in schools in which its research findings revealed that ventilation was one of the major problems faced by occupants (Mohd Salleh, Ku Hassan, & Kandar, 2006). This indirectly disrupted the students' learning environment and affected their performance. Meanwhile, a comparative study of classroom with air-conditioning and classroom with natural ventilation discovered that this had no difference or effect on the students' performance (Mishra & Ramgopal, 2015). In fact, a study of natural ventilation in office spaces in school buildings has discovered that passive design elements are not factors that determine the effectiveness of natural ventilation performance, especially in the context of the tropical climate. This occured because the necessity of mechanical ventilation systems and equipment were used to achieved user comfort level (Chan, Che-Ani, & Nik Ibrahim, 2013). In contrast, a study by Liping & Hein (2007) found that the maximum openings or optimisation of window-to-wall ratio create high air intakes, thus improving indoor thermal comfort to allow natural air ventilation (Liping & Hien, 2007).

Maximum opening is among the typical elements used in implementing strategy to achieve optimum use of natural ventilation. Opening can be applied with the use of window or screen. Ventilation block is one of the elements used to form wall screen. Also known as perforated bricks, breeze blocks or concrete blocks, apart from allowing cross ventilation, ventilation block is also used as a filter for day lighting, shadow casting, and creating an aesthetic impact to the design of the building. The idea of these architectural screens or patterns formed by modular volume has been applied for quite some time in the construction industry. It used to be one of the key building elements in tropical climates, subtropical and arid areas. The usage of ventilation blocks for buildings in hot and humid regions makes living more comfortable and energy efficient in the adaptation of passive design features. These perforated or hollow bricks are often made of concrete that can be used for exterior wall, partition, openings, and as interior wall decoration because they are durable, resistant, lightweight, and easy to be molded. These bricks allow air to pass through, create privacy for the occupants in the building, and can filter excessive light radiation. In addition, the modular production not only simplifies the manufacturing and construction process but these lightweight concrete screens can also allow

cross ventilation and protect the interior of a building from tropical rainfall (Schätz, 2013).

Ventilation blocks has been commonly used in South East Asian countries. They can be seen adorning the old office buildings, houses, and schools either as a wall panel on staircase façade, features in corridors, or used as wall screens covering private or semi-private spaces. Wet or damp spaces such as kitchen, bathroom, and yard are among the spaces where these elements can be found as the use of ventilation blocks allows natural air ventilation. The thickness of at least 3 inches is required to ensure a strong structure and ease of construction with a rectangular or square with opening in the centre being the most commonly used forms to allow ventilation (Chee Kien, 2013). Although the usage of ventilation blocks could be traced a long time ago, it disappeared from the Malaysian building design, especially after the era of modern technology in which the usage of glass on windows and building facades has replaced ventilation blocks. Hence, ventilation blocks are now considered irrelevant in the present era of modern technology. However, by bringing them back into building design, current designers have made an effort by designing modern ventilation blocks that still retain their original features and functions. As a result, many present-day buildings with ventilation blocks can be found in Malaysia, such as the Gardenwall offices in Petaling Jaya which were designed by a local architect, Kevin Mark Low.

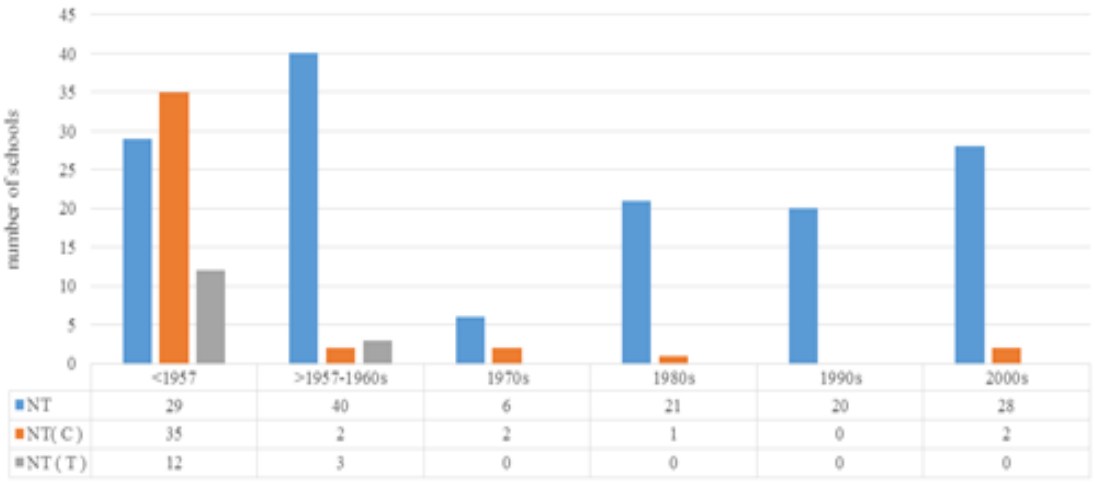
2. CASE STUDY: KUALA LUMPUR PRIMARY SCHOOLS

This study is part of a larger research which investigated the effects of passive design features on students' achievement. The main passive design features in the existing Malaysia public schools included ventilation and day lighting and with elements like shading devices, ventilation blocks, and opening sizes. This paper focuses on one of the design elements, namely, the ventilation blocks in the existing primary school buildings in Kuala Lumpur. The main objective of this study was to investigate and identify the types, the design and the characteristics of the ventilation blocks found in the selected school buildings. Two methods used to collect data in the study were observation and document analysis of photographs and notes. Prior to data collection, previous studies published in journals, conference papers and books were reviewed. Primary school is suitable for the study because the level of education is simpler and has no diversity in terms of the learning specialisation compared to other type of educational facilities. In addition, the physical development requirements for primary schools such as size of classroom, number of subjects and rooms needed is less, not too complicated and simple enough for the purpose of this study. Primary schools located within the Federal Territory of Kuala Lumpur were chosen because the schools were built ever since before the country gained independence until the year 2015. The researchers in the present study had regularly updated the list of schools with the Malaysia Ministry of Education. As of July 2015, there were 201 primary schools listed in Kuala Lumpur out of the total 7,760 primary schools in Malaysia. These schools included National Schools (*Sekolah Kebangsaan* - NT), National-Type Schools or Vernacular Schools [*Sekolah Jenis Kebangsaan* - NT(C) or NT (T)], and Special Education Schools (*Sekolah Pendidikan Khas* - SE) (Ministry of Education Malaysia, 2013). The difference between these school types was the language used as the medium of instruction for teaching. However, SE type schools were excluded from this study because these schools had special facilities and run a different curriculum with different syllabuses compared to the other school types. The information available about each of 201 schools was collected and categorised according to the year it was founded so that observation could be carried out comprehensively on schools that represented every era (see Figure 1). A total of the 201 schools had been identified and zoned by location and year they were founded. Applying the probability sampling design type, samples for this study was determined by using the stratified sampling technique. This technique is suitable for this study because it was found that the schools have various design types and characteristics. Since it is heterogeneous, therefore it is necessary to stratify the schools into homogeneous groups before samples can be determined. By using the stratified technique, 85 schools were shortlisted and site visits to these schools were carried out to determine the physical environment and the architecture of the existing schools according to the forms provided. The form consisted of a list of physical parameters such as orientation, openings (including windows and doors), building forms, materials, colours, surrounding environment such as the existence of landscape and vegetation, and other design-related issues. Photos and sketch-out plans were used as photographic evidences in the observation.

Before observation was made, preliminary investigation and analysis on the background of

the schools had been conducted. Schools were grouped according to the year they were formed based on the secondary data provided by the Ministry of Education (MoE). The initial analysis had revealed that there were 201 public primary schools in Kuala Lumpur financed and operated entirely by MoE. Later, these data were combined with the data on the year which the schools were built. Since there were school buildings in the same compound that were built in different years, the exact year in which the school buildings were built could not be determined from the record. Therefore, the list of schools was filtered and grouped by the era they were formed or founded. This was aimed at gaining an understanding of the relationship between the design of the school building and the history as well as the architectural influences of the era they were formed.

Chart 1 shows the number of schools according to type and era they were founded. Statistics show that 76 schools had existed before Malaya gained independence in 1957. After independence until the end of 1960s, the number of National Type Schools increased dramatically as a result of the changes in the national education policy in merging the diverse school types which was newly introduced at that time (Lee, 1997; Mior Jamaluddin, 2011). The number of schools further increased in 1980s, during which there was increased demand for the admission of new students and this continued until the 1990s. The increase in 1990s was likely due to the new act introduced in 1993 which made it compulsory for all children at the age of six years old to register and attend primary school (Kementerian Pendidikan Malaysia, 2012). Meanwhile, in line with the National Education Policy, vernacular schools continued to exist but the number of these schools was reduced compared to that in the pre-independence era



	<1957	>1957-1960s	1970s	1980s	1990s	2000s
NT	29	40	6	21	20	28
NT(C)	35	2	2	1	0	2
NT(T)	12	3	0	0	0	0

Chart 1: Tabulation of number of public primary schools in Kuala Lumpur

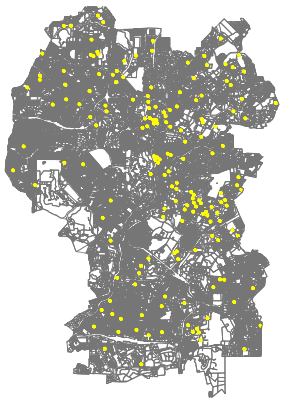


Fig. 1: Distribution of public primary schools to the year they were formed or founded

2.1 SCHOOL BUILDING DESIGNS

In general, there have been no major changes in school building design in Malaysia in the past five decades. Based on the observation made, researchers were able to identify the reasons behind the design variations of the school buildings sampled in the present study. It was observed that 38% of primary schools sampled in Kuala Lumpur could be categorised as being formed in the pre-independence era. These schools were found to have diverse designs noticeably influenced by the history and the culture which were initiated by the local communities that shared the same goal, that is, to provide education to children. However, the teaching was limited to the theology-based knowledge. Hence, there were traditional Islamic religious schools in the Malay villages that were oriented towards Islamic religious studies, as well as Chinese and Tamil schools in which the teachings were oriented towards the culture and religion of these people. Design varieties and elements were found on these schools which was influenced by the architecture of their home countries.

Fig. 2: Grouping on school building designs based on the year the schools were formed or founded

It was also observed that the designs of these schools could be summarized into two types, namely, the one-off design and the standard design. The one-off design refers to the design that includes unique layout and façade and may not be found on other buildings. Results indicated that the one-off design could generally be seen in school buildings that were formed and built in the pre-independence era and in the post-millennium era. The features found on these school buildings were different, unique and improved over time. Meanwhile, the standard design is defined as the design that includes repeated façade design, layout, space planning, and the material used. This type of design could be classified into three groups, namely, the era of post-independence until the 1970s, the era between 1980s and the 1990s, and the post-millennium era. Although there were insignificant differences in the designs of the façades in these three groups, other characteristics such as the form and layout of the room, the size and capacity, and facilities provided were found to be similar. In fact, there were schools that had designs comprising four eras as a result of newly added buildings and renovations made throughout the time these schools were utilised. Usually, the standard design would be used to reduce the time, labour and costs incurred to produce a large number of school buildings to meet the demand. Figure 2 illustrates the conclusions drawn from the findings of the observation made on the selected 85 primary schools in the Federal Territory of Kuala Lumpur in visual form.

Factors considered in designing a school building are circulation, layout, daylighting, ventilation, safety, and many others (Moore & Lackney, 1993; Robinson & Robinson, 2009; Uline & Tanner, 2009; Yang, Becerik-Gerber, & Mino, 2013) including key factors related to the energy efficient design namely, ventilation, lighting and acoustic. Based on the design guidelines provided by MoE (Jawatankuasa Standard dan Kos, 2015), it is coincided that public schools in Malaysia are using natural ventilation with the support of mechanical ventilation and sunlight for lighting, which suits the theoretical of passive design strategy defined as producing energy efficient buildings but yet still maintaining user comfort (Mardon & Jaques, 2008). In order to implement the passive design strategy, there are a number of design features that need to be adapted in the design of the building. Based on the observation of the sampled public primary schools buildings in Kuala Lumpur, it was discovered that there were many interesting features in the school buildings with one-off design. Among these were sun shading devices, ventilation blocks, room

heights, building layout and opening of window sizes. In theory, these features may have an impact on building energy consumption, give comfort to the occupants and also create varieties to the building design facades. Although the same standard school design had been applied in the era of the 1970s until the 1990s, this design still retained some features found in building with one-off design and among these were either vertical or horizontal sun shading devices. All of these features gave a different impact on energy consumption and occupant comfort. However, this paper will only discuss one of these features which is ventilation blocks.

3. VENTILATION BLOCKS

Ventilation block is one of the main features that was found during the observation of the selected school buildings. Out of the 85 schools visited, only 27 schools had ventilation blocks with various designs and patterns. It was found that most of the schools with this feature were built before the independence up to the 1960s. This verified that ventilation block was once an element favoured by the designers in designing school buildings. This element cannot be formed by using only one block, but requires the continuation of this block to form wall panel or screen. The most common ventilation blocks were rectangular or square in shape and out of these, the basic form was modified to give an impact of different wall patterns. There were also innovative forms that used geometric shapes such as hexagons, triangles, octagons, as well as semi-circles. Various forms can be designed creatively as long as they can be connected at the top and the bottom to carry the load.

The findings of the present study whowed that there were four main forms found. Ventilation blocks had been modified but generated from the same basic forms. Figure 3, Figure 4, Figure 5, and Figure 6 show the basic rectangular forms while Figure 7, Figure 8, Figure 9, and Figure 10 show the square forms with different patterns created in the centre of the blocks. Meanwhile, Figure 11 shows a strong hexagon form in contrast to the octagon form as shown in Figure 12. The most common forms of ventilation blocks found were the rectangular or square designs with a perimeter of concrete forming their respective shape. Among the many designs of ventilation blocks, the modules were the most often found in school buildings. Figure 3 shows ventilation blocks arranged vertically and in parallel to each other to form a wall screen such as the one found at Sekolah Kebangsaan Seri Dhandayutaphani academic buildings built in 1963. These wall screens created a barrier to the corridor spaces and acted as design feature to this school.

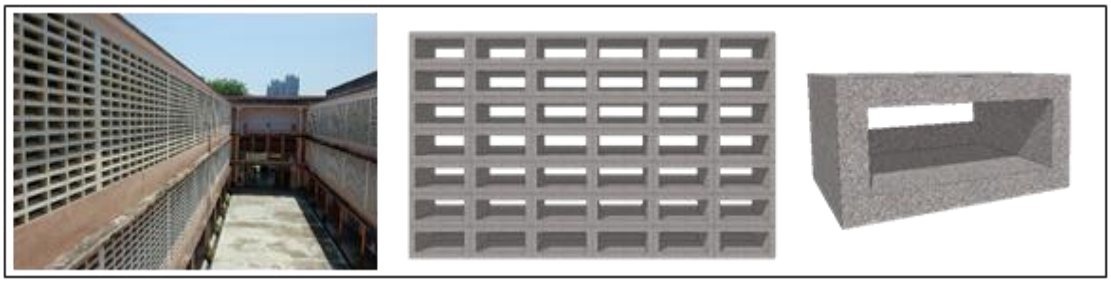


Fig. 3: Stacks of rectangular shaped ventilation blocks creating a wall screen along the corridor of the school building

Even though the block design was simple and mundane, it allowed maximum ventilation and optimum natural daylight penetration by exploiting the large opening area. Simultaneously, it could also refract natural daylight in order to avoid glaring effect and create a pleasant space to work in. However, the design and the thickness of these blocks with flat flange on one side were as such to prevent rainwater from entering the corridor. Beside Sekolah Kebangsaan Seri Dhandayutaphani as shown in Figure 3, this type of ventilation blocks was also be found in various locations such as Sekolah Kebangsaan Convent Jalan Peel, Sekolah Kebangsaan Jalan Gurney 1 & 2 and Sekolah Kebangsaan Kampung Bharu. Using the same blocks, Figure 4 shows the design with single sided flat flange arranged horizontally staggered enabling varying designs of the wall panel. Blocks had been arranged apart from each other to create gaps that would likely reduce the material use. Sekolah Kebangsaan Jalan Hang Tuah (see Figure 4) was found to have this feature along the corridors as well as on some of the classroom walls. As with other school such as Sekolah Kebangsaan La Salle Brickfields 1 & 2 and Sekolah Kebangsaan Sultan Hishamuddin

Alam Shah, the feature could also be found in the corridors, staircases and canteen area.

Fig. 4: Rectangular shaped ventilation blocks arranged in horizontally staggered design and apart from each other creating a different effect to the wall screen

Ventilation block design in Figure 5 was found to have closely resembled the design in Figure 3 and 4 but still retaining rectangle as the basic form and with a formation of rectangular hollow in the centre. The difference between this design and the previous design was by having flat flanges on both sides to give better function in filtering the heavy rain and direct sunlight while still allowing air to pass through. This type of block design could be seen on the facades of Sekolah Kebangsaan Puteri Pandan 1 & 2 buildings which were built in the year 1962 and other schools in various locations such as Sekolah Jenis Kebangsaan (Cina) St. Teresa Brickfields, and Sekolah Kebangsaan (P) Jalan Pudu 1 & 2. Most of these were located on the facade of a staircase area. As shown in Figure 5, other than the staircase area, it was observed that in Sekolah Kebangsaan Puteri Pandan 1 & 2 buildings, such element could also be found on half of the wall of the classrooms. However, the ventilation blocks in the classrooms area were enclosed with a brick wall for unknown reasons. Although the size and horizontal staggered arrangement were found to be the same as those shown in Figure 4, small changes in design of flat flanges showed a different impact when the blocks were arranged into wall panels. Parallel horizontal and vertical arrangements were also observed in some of the façades of the schools visited.

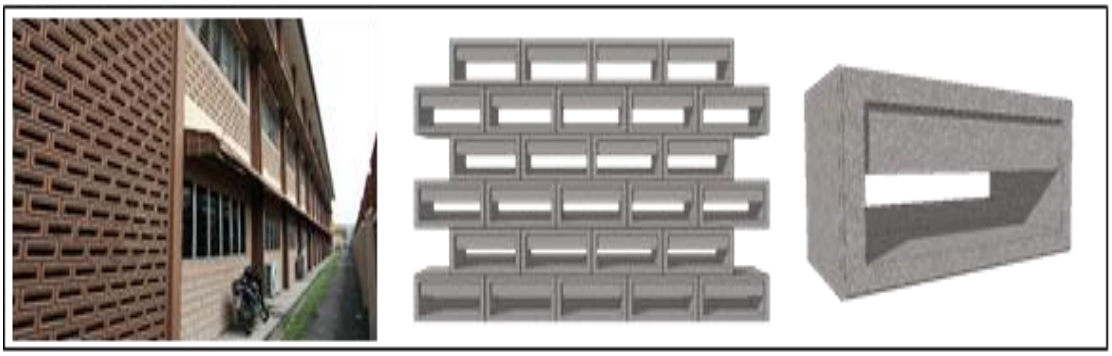


Fig. 5: Rectangular shaped ventilation blocks arranged horizontally staggered with flat flanges on both sides

Figure 6 shows ventilation blocks using the same rectangular basic form as in the previous design. These ventilation blocks had been modified by reducing the size and creating a chamfer at the top and the bottom of the blocks. The purpose of this modification is to reduce material consumption and minimise the risk of damage during shipping or construction works. It was designed to form patterns that would be different from the typical ventilation blocks design when combined to form a wall panel (Chee Kien, 2013). This block design could be found on the facade of Sekolah Kebangsaan Dato' Abu Bakar which was built in 1962 (see Figure 6) and Sekolah Kebangsaan (L) Jalan Pasar 1 academic buildings. Arranged horizontally staggered design, these ventilation panels were placed as a separator in the corridor by alternating the placement of the panels with openings to create interesting visual in the design of the school building façade. This may avoid monotonous design often seen in other school buildings.

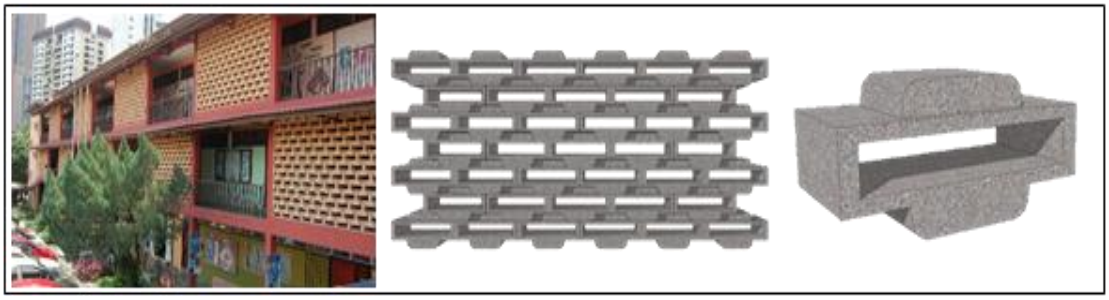


Fig. 6: Modified rectangular shaped ventilation blocks arranged horizontally staggered creating a unique wall screen

Square is among the most often used forms in the design of ventilation blocks. Figure 7 shows the design of ventilation blocks that use square as the basic form. As shown previously in Figure 5, ventilation blocks of this type has flat flanges on both sides which aims to prevent the conceded of rainwater and direct sunlight. This design have openings and flat flanges on both sides which make it analogous of the periscope design and give privacy to the occupants behind the ventilated walls. Maintaining the basic shape and a simple design, this type of ventilation blocks was observed in the façade of Sekolah Jenis Kebangsaan (Cina) Tsun Jin academic buildings which were built in 1962. Arranged vertically staggered, these ventilation blocks acted as a wall panel and interspersed with casement windows of a classroom. Apart from avoiding the monotonous façade design, this also gave aesthetic value to the school academic buildings.

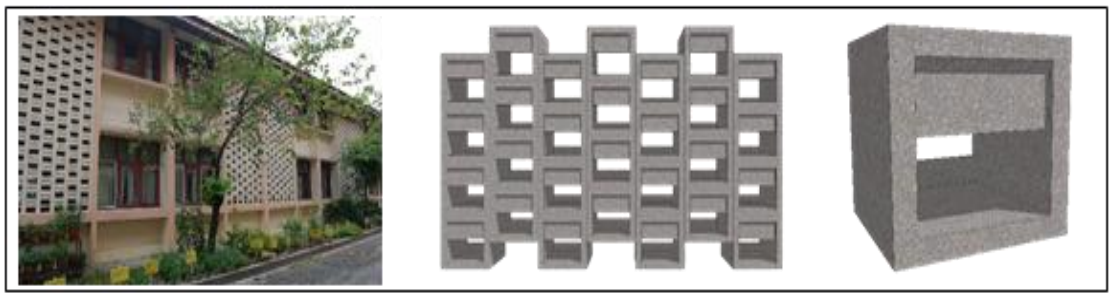


Fig. 7: Basic square shaped ventilation blocks arranged vertically staggered with flat flanges on both sides

By using square as the basic shape, ventilation blocks shown in Figure 8 resembled the previous ventilation block design (see Figure 7) but with internal flat flange on one side. Flat flange on the exterior was replaced with square design element on the left corner of the block and the modules were arranged vertically and parallel to one another to create a wall panel. The square elements and the flat flanges are intended to prevent the rainwater and direct sunlight while providing privacy to the occupants. This square element also gives a three-dimensional effect on the facade of the building when arranged into a wall panel. Figure 8 shows the ventilation blocks found on the facades of Sekolah Kebangsaan Convent Sentul academic buildings, which were built in 1961. The feature wall was located near the entrance and facing the main road, giving an appealing image to the school. Not only that the blocks could be seen as a wall panel but also as sun shading devices located along the school corridors.

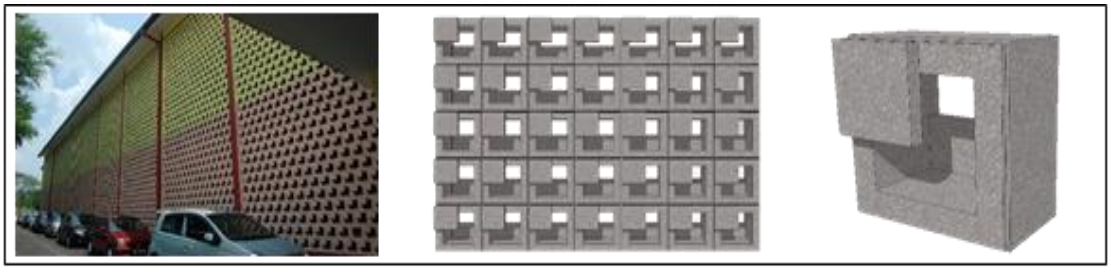


Fig. 8: Square shaped ventilation blocks with square element on one side and flat flange on the other creating a three-dimensional effect on the wall screen

Still retaining the square as the basic shape, Figure 9 shows ventilation block design with three-dimensional effect. Featuring a four pointed star-shaped opening, these ventilation blocks are designed with different depths. Fitted with a perimeter frame each, this type of ventilation blocks has a different thickness starting from the edge of the frame, with decreasing thickness at the centre of the block. These ventilation blocks were found on Sekolah Kebangsaan Convent Jalan Peel classroom walls which were built in 1961, dividing the classrooms from a covered corridor. Arranged vertically and parallel to each other, this type of ventilation block design allowed ventilation and natural lighting into the classrooms. However, it was discovered that this design could not prevent rainwater from entering the classroom areas.

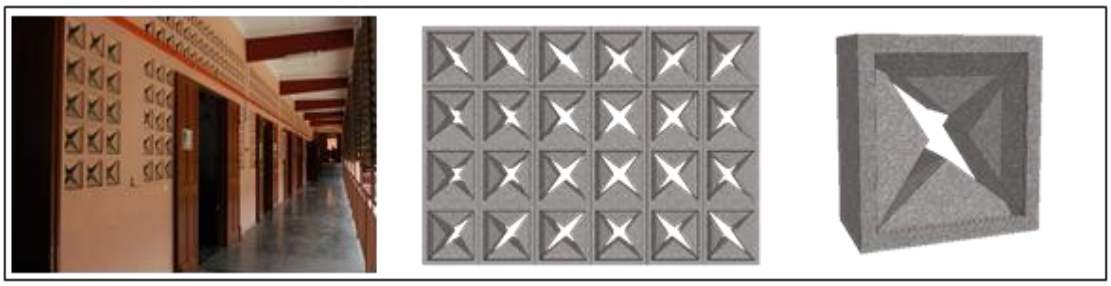


Fig. 9: Square shaped ventilation blocks with perimeter frame and star shaped opening in the centre of each block

Although using the same basic square shape as the one shown in Figure 9, the design shown in Figure 10 had a different opening pattern and the surface was flat without the embossed effect. Like a floral pattern, it had a symmetrically geometric shape design with many small openings compared to the previous design. Such design, which was found on the wall of staircase area and on the top of the door opening at the assembly hall of Sekolah Kebangsaan Convent Jalan Peel, allowed cross ventilation and natural light to enter the designated spaces. However, this design may not be able to prevent rainwater since there was no flat flanges element on the ventilation blocks. Considering this to be used as a wall located next to the covered corridor and also as staircase walls, it can be concluded that this coincided with the purpose of using ventilation block as decorations, dividers while at the same time served the purpose of using ventilation blocks to allow cross ventilation and natural lighting.

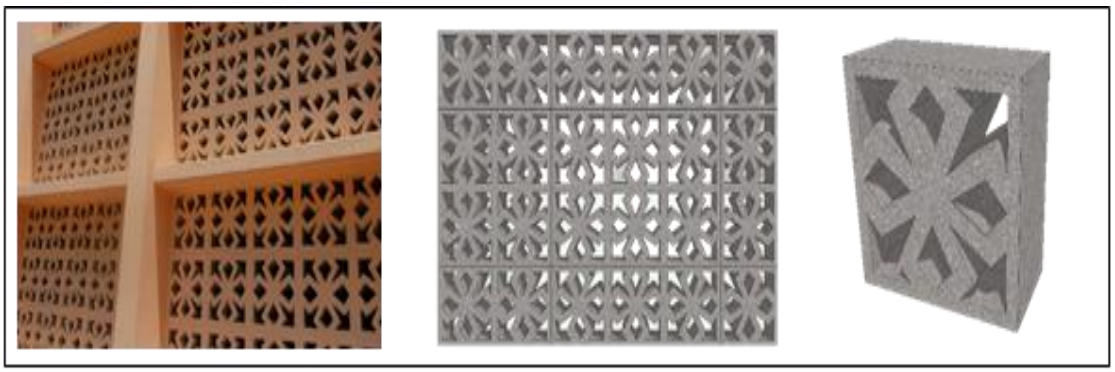


Fig. 10: Square shaped ventilation blocks with flat surface and floral pattern found at staircase facades

Figure 11 shows the design of ventilation blocks with hexagon as the basic shape. This type of ventilation blocks design was found in some parts of Sekolah Jenis Kebangsaan (Cina) Nan Kai academic buildings which were built in 1949. The ventilation blocks were found as part of the staircase wall and at the façade of the centre of the long corridor of these linear-shaped buildings. The half openings on each side of these modules make them appear like a periscope. Not only that these blocks allowed ventilation, they also allowed indirect natural light to the room or areas. Blocks arranged into panels and arranged horizontally staggered created a feature wall with honeycomb effect, giving a unique feature to the design of the school building facade.

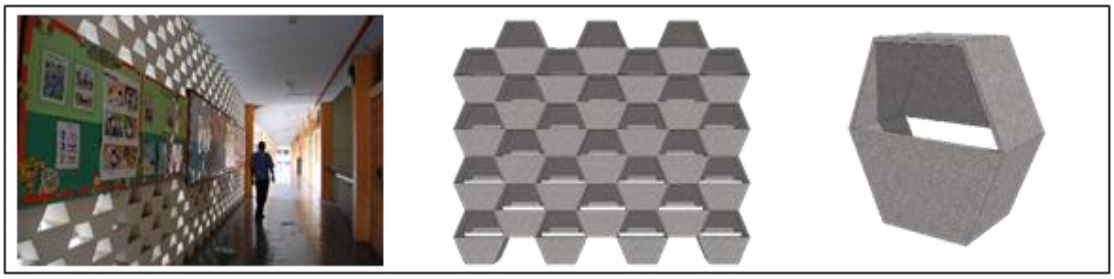


Fig. 11: Clear hexagon shaped ventilation blocks with half openings on both sides forming a honeycomb effect when arranged into wall screen

Figure 12 and Figure 11 show similar basic ventilation block designs. Although the blocks are similar, the design of ventilation blocks in Figure 12 has an octagon as the basic shape and arranged vertically and parallel to one other. These ventilation blocks have eight sided and four of their sides had the shape of quarter circle each so that a hollow circle can be formed when the blocks are arranged into a wall panel. In addition, a different thickness on the surface of each ventilation block gives an embossed effect to the entire block design. It was observed that this design did not only provide a creative feature to the building facade, but it also did give ventilation and natural lighting to the space designated. However, due to its design, it could not filter rainwater from passing through the blocks, making this design not suitable to be applied for workspaces and classrooms. This type of ventilation blocks were found on the facade of Sekolah Kebangsaan Jalan Gurney 1 & 2 academic blocks, which acted as a wall screen at the centre of the linear-shaped buildings. In addition, these blocks were also found at Sekolah Kebangsaan Kampung Bharu as an entrance wall to the office space which was covered by a roof (see Figure 12).

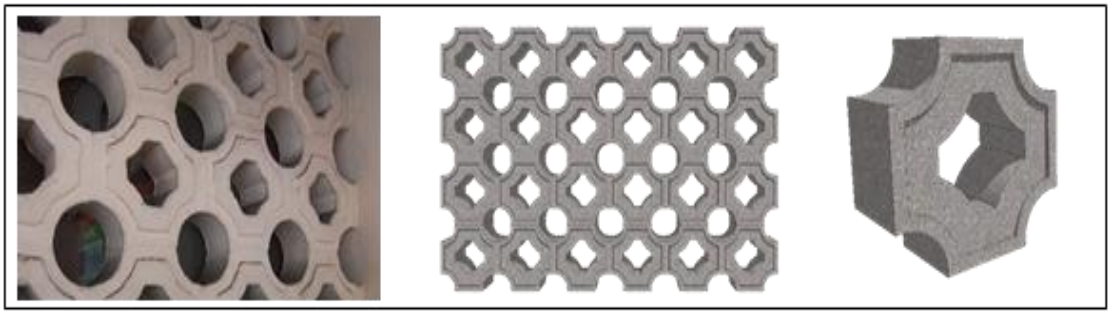


Fig. 12: Modified octagon shaped ventilation blocks with quarter circle each on four sides creating a hollow circle when arranged into a wall screen

4. DISCUSSION

Observation made on the selected 85 primary schools in Kuala Lumpur showed that the design of public primary schools can be divided into two: one-off design and standard design. The ventilation blocks could only be found in 27 of 80 school buildings sampled which were formed or founded before Malaya gained independence in 1957 until the late 1960s. In the 1970s and thereafter, ventilation blocks were no longer used or they were not favoured in the construction of school buildings. This was likely due to the existence of standard design plans in order to produce standard school buildings by taking into consideration key factors such as cost, time and, minimum use of labour.

There a less research found on ventilation blocks, however many research found on the significants and benefits of ventilations towards human and environments. Two scholars, Chien Kee Lien and Florian Schatz has written in details about the fundamental and functions of this feature. In line with the statement by Chien Kee Lien (2013), these various types of ventilation blocks could easily be found in spaces such as classrooms, corridor, and staircase façades. These blocks were used as decorations, feature walls and room dividers that provided privacy to the occupants. On the exterior building, ventilation block walls formed unique and harmonious patterns on the facade of the building in contrast to the glass or steel curtain walls which are frequently used these days. Apart from being a feature wall, in order to

produce ventilation blocks that function optimally, the key factors to be considered in the design of ventilation blocks included natural lighting, shadow, privacy, air movement and water penetration. Agreed with Schatz (2013) statement, the ventilation blocks have not only functioned as decoration and medium for space dividers, but these elements can also contribute to achieving the implementation of passive design strategies in building design, allowing cross ventilation and natural lighting in the buildings. In addition, ventilation blocks not only have aesthetic value of their own, they are also easy to maintain, readily available, inexpensive, and more importantly, they are also environmental friendly. Although, studies on the effects of ventilation blocks on occupants and building performance has not been proven yet, but based on the literature review noted earlier, natural ventilation may offered many benefits to human and environment (Bakó-Biró et al., 2012; Firth & Cook, 2010; Liping & Hien, 2007; Ng & Wong, 2004; Wang et al., 2014). Thus, buildings that have applied natural ventilation in their design, such as in public schools which are maintained and operated by the government, are highly recommended to use ventilation blocks as a potential strategy to achieve comfortable interior space as well as optimal energy efficiency.

5. CONCLUSION

Although gradually being almost forgotten, ventilation blocks had enlivened the design of school buildings in Malaysia as early as the 1950s until the late 1960s. This feature had not only contributed to the aesthetic value of the design of such building but it may had also given the impact on the environment in general. Their low maintenance and ease of application make installation of ventilation blocks worthy of consideration for buildings that applying the concept of natural ventilation. In terms of design matters, ventilation blocks have indeed made a comeback which is becoming a new trend in building design. This is evident from various buildings in post-millennium era which have applied modern ventilation block design as their interior or exterior features to meet the criteria of contemporary and futuristic buildings. These ventilation block designs might have been simple, but such designs can be reinvented, yet still maintaining their functionality and their original concepts which help to create modern and up-to-date designs in line with current building façades.

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